UNITED
NATIONS

DP

Governing Council
of the
United Nations
Development Programme

Distr.
GENERAL

DP/GLO/FINAL REPORT/9
13 August 1984

ORIGINAL: ENGLISH

GLOBAL RESEARCH

Technology transfer on root and tuber crops
GLO/79/013

Final report by the International Centre for Tropical Agriculture (CIAT), Cali, Colombia, the International Potato Centre (CIP), Lima, Peru, and the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, covering the period June 1980-June 1982

Note by the Administrator

1. In September 1982, phase 1 of the above-mentioned project approved by the Governing Council of the United Nations Development Programme (UNDP) was completed. Tropical root and tuber crops - cassava, sweet potatoes, yams, the aroids and white potatoes - are major sources of food in the world today. An estimated 3 billion people or 70 per cent of the world's population consume these crops on a fairly regular basis and at least half of these people consume them as staple foods. Most of these crops are consumed directly as fresh food, although recent research has focused on developing alternate products, such as animal feeds, manufactured foods and industrial products to reduce market losses resulting from the high perishability of the fresh commodities. Most of the production of these crops is concentrated in Central and South America, central Africa and south and east Asia, with China, Nigeria and Brazil being the leading producers. The major two crops are cassava and sweet potatoes of which over 90 per cent is grown and consumed in developing countries. These crops produce more energy per hectare per day than most popular foods including rice, maize, beans and chick peas.

2. In spite of the potential of these crops to produce an enormous amount of energy per hectare, they have received much less attention than cereals in terms of research on improvement of yields, nutritional quality and range of adaptation. Recognizing these facts and the crops' potential for alleviating world hunger, the international research centres - CIAT, CIP and IITA - have been mandated by the Consultative Group on International Agricultural Research (CGIAR) to conduct research on these crops with the objective of assisting national programmes to

adapt and generate new technologies for increased production. Each of these centres of the CGIAR system has been assigned a specific mandate: CIAT in cassava (worldwide), CIP in white potato and IITA in cassava (for Africa) sweet potato, yams and cocoyams. Their institutional framework is geared to their respective mandates and to the world-wide or regional focus of each centre.

3. The research programmes of CIAT, CIP and IITA have focused on the collection, exchange, evaluation, selection and improvement of crop germ plasm, breeding for resistance to major pests and diseases and the development of simple technologies based on existing farming systems. The international centres transfer the improved technologies directly to national programmes, which have the responsibility of ensuring that the technologies ultimately reach the farmer. In order to increase the capabilities of national programmes in receiving and adapting the technologies to their own conditions, the international centres have undertaken extensive training and outreach programmes with the national programmes. Group and individual training courses addressing specific aspects of root and tuber crop research and production are sponsored by the institutes. A collegial atmosphere between the centres' staff and national programme staff is fostered by many conferences and workshops in order to create the necessary centre-national programme partnership to facilitate the information exchange and co-operation which is vital for the success of each institution's work.

4. During the project's two years, 784 national programme research scientists, extension agents and administrators participated in training activities sponsored by the centres. Many of the training activities which were formerly undertaken at the centres' headquarters are now being undertaken on a regional basis with a participating country institute acting as the host. National country staff are course instructors and local problems are examined as part of the course curriculum. In this manner, the international centres can assist the national programmes by providing them the capability to find solutions to their own country-specific problems. Collaborative arrangements to facilitate freer transfer of germ plasm between countries has resulted because of centre-sponsored quarantine exchange workshops. Local crop varieties with superior characteristics are now being produced and released to farmers by the national programmes as a direct result of centre-national programme collaboration. Most of the current heads of national root and tuber crop programmes are former centre trainees. Handbooks on root and tuber crop research and production have been written and distributed by the centres in English, French and Spanish.

5. CIAT, CIP and IITA collaborate closely with the Food and Agriculture Organization of the United Nations and with the International Fund for Agricultural Development (IFAD).

6. In line with the strong recommendations of a UNDP-appointed independent consultant mission which, in November 1981, evaluated the progress and accomplishments of the project, UNDP assistance for continuing and expanding the project activities has commenced for an additional five-year period until June 1987. An expanded programme has been undertaken including more in-country training courses, joint centre thematic workshops and provision for advanced degree studies for promising young developing country scientists to undertake their thesis research at their national universities in collaboration with the international centres.

7. UNDP participation in global and agricultural research was due largely to the imagination and foresight of the first Administrator of UNDP, the late Paul Hoffman, who recognized the great importance of such endeavours for which he took the initiative and gained the approval of the UNDP Governing Council in 1970. 1/ Since that time, the primary sectoral emphasis under the global programme has continued to be placed on support to international agricultural research which has an immense potential for enhancing food production in developing countries. The global inputs of UNDP into a number of specific research programmes at selected international agricultural research centres have already begun to show promising results which are being translated into action programmes to increase food production in developing countries. In this endeavour, the entire scientific and management staff of CIAT, CIP and IITA are playing a vital and inspirational role. Such dedicated and sincere efforts have contributed in no small measure to the successful development of the centres' various research programme. UNDP is proud to be associated with these three institutions which have a sound philosophy, highly qualified staff and resources needed to improve the present world food situation.

Notes

1/ Official Records of the Economic and Social Council, Forty-ninth Session, Supplement No. 6 (E/4782), para. 16 (i).

CONTENTS

		Page
I.	INTRODUCTION	6
	A. General background	6
	B. International root and tuber crop research and training	7
	C. Root and tuber crop improvement programmes at three international agricultural research centres	7
II.	INCREASING NATIONAL CAPABILITIES TO TRANSFER IMPROVED TECHNOLOGIES	8
	A co-ordinated effort	8
	Cassava at CIAT	9
	Potatoes at CIP	10
	Sweet potatoes and cassava at IITA	11
	Collaboration	12
III.	OUTLOOK FOR THE FUTURE	12
Appendix 1.	A compilation of training activities of technology transfer on root and tuber crops (GLO/79/013)	15
Appendix 2.	Countries assisted by UNDP root-tuber crops project showing number of professionals trained	18

I. INTRODUCTION

A. General background

1. Except for cereals, root and tuber crops are the most important group of staple food in the tropical world. As illustrated in the table below, 48 million hectares of tropical land produced over 561 million metric tons of roots and tubers in 1981.

World root and tuber production

	Area a/	Yield b/	Total production c/
Cassava	14 054	9 055	127 261
White potatoes	17 861	14 387	256 970
Sweet potatoes	11 771	12 384	145 765
Total root and tuber crops d/	48 164	11 660	561 567

a/ 1,000 hectares.

b/ Kilograms/hectare.

c/ 1,000 metric tons.

d/ Includes taro, yams and minor aroids.

Source: FAO Production Yearbook, vol. 35, 1981.

In Africa, Latin America and the Caribbean, India, South-East Asia and the Pacific islands, one or more of the tropical root and tuber crops, primarily white potatoes, sweet potatoes and cassava, constitute the major food item in the human diet and, in some regions, the major staple food.

2. Prior to the 1970s, agricultural research on these crops had been scant, owing to their less prestigious position in the market place than that of cereal crops. However, their importance for local and international food security has recently become recognized. Their high potential as an energy source in regions affected by malnutrition and adaptation to adverse cropping conditions makes these crops highly attractive in helping to alleviate world hunger. Some of them can be stored in the ground or with minimum processing and used during periods of famine, thus making them food security crops for farmers who cannot afford costly storage facilities. They are also becoming a source of cheap, locally grown animal feed.

3. Root and tuber crops are produced by small farmers who use agronomic practices that are not dependent on inputs associated with modern agriculture. To increase yields under the socio-economic conditions of the producers, research is oriented towards developing improved germ plasm adapted to varying soil and climate conditions, as well as encouraging new cultural practices which will result in a superior quality product at minimum cost.

B. International root and tuber crop research and training

4. As an effort to increase the quantity and improve the quality of food production in developing countries, the Consultative Group on International Agricultural Research (CGIAR) was organized in 1971 by its three co-sponsors, the World Bank, the Food and Agriculture Organization of the United Nations (FAO) and UNDP, to bring together countries, public and private institutions, international and regional organizations and representatives from developing countries in support of a network of international agricultural research centres. This network currently consists of 13 international centres whose research and training activities deal with crops and livestock that encompass three quarters of the food supply in developing countries. Three of these centres, which have been mandated by CGIAR to conduct research and training activities on selected root and tuber crops with the objective of assisting national programmes in generating and adapting new technologies for increased crop production, are the International Centre for Tropical Agriculture (CIAT), the International Potato Centre (CIP), and the International Institute of Tropical Agriculture (IITA).

5. It is the policy of the international centres to transfer technology directly to national research institutions, and the national programmes have the responsibility of ensuring that the technology ultimately reaches the farmers. Simultaneously, the international centres encourage this process through the interaction of their principal staff with personnel of national research and extension organizations in the concerned countries and through assistance to in-country training and the organization of local events.

C. Root and tuber crop improvement programmes at three international agricultural research centres

6. Research activities at CIAT focus on those crops which provide a real solution to the nutritional deficiencies of low-income populations, particularly in Latin America, and the exploitation of which is compatible with the existing cropping systems and cultural practices of the producers. Cassava, beans and rice are the basic food commodities being investigated by CIAT, as well as tropical pastures suitable for beef and milk production in the acid soils of the tropics. While CIAT has its headquarters in Cali, Colombia, the cassava programme includes research under six soil-climatic conditions representing most of the cassava production areas of Latin America and the Caribbean, Africa and Asia and the Pacific.

7. The mandate of CIP is to develop, adapt and expand the research necessary for the development of technology which will solve the problems that limit white potato production in developing countries. This includes adapting the collective knowledge that has contributed to increased potato production in developed countries. CIP's headquarters is located in Lima, Peru, but in order to carry out effectively its global mandate, CIP has seven regional offices in Colombia, Brazil, Kenya, Turkey, Tunisia, India and the Philippines. The network also includes close collaborative linkages with country programmes in Rwanda, Sri Lanka, Bangladesh, Bhutan and Burundi.

8. IITA, located in Ibadan, Nigeria, has the geographical mandate for crops in the world's humid and subhumid tropics and concentrates its research and training in three major areas: farming systems (rice and maize), grain legumes (cowpeas and soybeans), and tropical roots and tubers (cassava, sweet potatoes, yams and cocoyams). IITA has given particular emphasis to developing technologies adaptable to African farming conditions and has a cassava improvement programme which works in collaboration with CIAT.

II. INCREASING NATIONAL CAPABILITIES TO TRANSFER IMPROVED TECHNOLOGIES

A co-ordinated effort

9. In June 1980, the UNDP Governing Council approved a two-year global project which launched a tri-centre, co-ordinated effort to transfer recently developed improved technologies for cassava, white potatoes and sweet potatoes from the international centres to developing countries by strengthening the capabilities of national programmes. The project was implemented by CIAT, CIP and IITA and conceived to accomplish the following goals:

(a) To strengthen the root and tuber crop research and extension capabilities of selected national programmes concerned with cassava, white potatoes and sweet potatoes; and

(b) To promote the transfer of technology emerging from the international centres for these three crops.

To meet these goals, operational objectives were established and focused on strengthening existing national programmes to conduct research and evaluation of the newly emerging technologies, catalyzing the horizontal exchange of knowledge between national programmes and facilitating the effective distribution of improved plant germ plasm.

10. A unified training programme was developed and implemented both individually and jointly by the three centres, with CIAT being the project's lead institute. Independent centre activities were emphasized in regard to each centre's mandate; however, joint activities were preferred when root and tuber crops could be considered together. The training involved specialized degree studies to bolster national research capacities, in-country and regional crop production courses to

facilitate research-extension interactions, and workshops and conferences aimed at bringing national collaborators together at regional and interregional symposia to collectively share accumulated knowledge and skills gained from the past decade's work on improving existing technologies. The compilation of training activities sponsored under the auspices of this global project, which is presented in appendix 1 to this report, indicates that 784 participants from 55 countries received training between 1980 and 1982.

Cassava at CIAT

11. After 10 years of research, CIAT's cassava programme has developed a technology that can produce high yields without great increases in production costs. This technology can be classified into four categories: (a) improved cultural practices; (b) testing and selection of new cassava germ plasm; (c) methods for processing and utilizing cassava; and (d) innovative research techniques. In addition, a large amount of basic knowledge about cassava has been accumulated and made available to national programmes and farmers through CIAT's training programmes.

12. A total of 203 trainees from 14 countries participated in CIAT's cassava training programme between 1980 and 1982 and were sponsored by UNDP. The training involved close collaboration between CIAT scientists and national personnel in the fields of agronomy, plant-breeding, genetics, physiology, entomology, plant quarantines and soil science. In-country field testing and production courses were held in Mexico, Colombia, Brazil, Haiti and the Dominican Republic.

13. Improved cultural practices have been developed including better methods for selection and treatment of planting materials, soil preparation, plant densities and distribution weed control, determining nutritional requirements, intercropping systems, timely harvest and introducing new types of equipment. Plant protection and pest management, including identification of insects and diseases affecting cassava yields and the use of natural enemies of insect pests in combination with selective insecticide treatments have been developed. For a crop such as cassava, with a long growth cycle (8-24 months), an integrated pest management system of biological control and insecticide application is critical for high yields and of less cost to the farmer. A four-week course on pest management methods, with emphasis on biological control and varietal resistance was held at CIAT in 1982 for six participants.

14. CIAT's breeding programme has the largest cassava germ plasm bank in the world. It is now possible to bring together many plant types (clones), representing a broad genetic base, from different areas, cross them, and higher yielding, more disease- and pest-resistant plants can be selected. To facilitate international transport of disease-resistant cultivars, CIAT has developed a meristem culture technique. Another technique developed increases the propagation rate of cassava cuttings, allowing rapid multiplication of the improved varieties. In 1981, CIAT sponsored 11 participants from nine countries in a meristem culture and propagation course. Many participants had already installed or were in the process of installing facilities for the introduction of new germ plasm. In 1982,

a similar course was jointly conducted by CIP and CIAT. A complete methodology for testing and selecting improved cassava varieties has been developed by CIAT and made available to developing countries. Between 1980 and 1982, 33 professionals from 10 countries in Latin America and the Caribbean were trained in cassava research methodology. Fourteen training internships were applied to two five-week multidisciplinary courses and followed up by a longer-term specialization course for 19 participants. After returning home, participants continue co-operation through field testing of new germ plasm and agronomic practices. As a result, such countries as Mexico, Cuba, Haiti and Colombia have already distributed to farmers new cultivars with high yield and resistant to disease (especially to common bacterial blight) and other adverse production factors. Other countries are in the process of evaluating germ plasm for future introduction into national programmes. Yields of the best local cultivars could be doubled by simple improvement of management practices (not including irrigation) and, if high-yielding varieties were introduced, yields could be tripled to more than 30 tons per hectare.

15. In order to use cassava for human or animal feed, the roots must be processed and subsequently used as flour in the bread industry and/or in balanced animal feed concentrates. CIAT has been investigating different systems for milling cassava flour to be used in poultry and swine rations and a pilot plant is in operation on the north coast of Colombia. Two courses, held in collaboration with two Colombian institutes, were conducted for 47 extension agents to transfer new cassava production and utilization technologies. As a result, five new drying plants are being constructed, and processed cassava flour is being now included in formulas by the feed industry.

Potatoes at CIP

16. A major constraint faced by farmers in developing countries is that white potato seed tubers, free from diseases and pests and genetically superior with respect to producing higher yields, are not available. This constraint is one which CIP, using the World Potato Collection, has a particular advantage in assisting national programmes to overcome. However, the effect that CIP can have at the farmer level depends not only on the genetic characteristics of improved germ plasm distributed but also on the existence of sound seed programmes at the national level and the appropriate management of the seed tubers at the farmer level. Therefore, CIP focuses on technologies and practices that could have an ultimate impact on improving the availability of good seed tubers to farmers. New technologies related to seed production, including seed identification and selection, storage, quality control and certification have been developed by CIP. A course was held in 1982 involving 24 participants from eight countries to give the participants a better understanding of the elements comprising a seed programme at the national level and to enable them to respond to problems faced by seed producers.

17. CIP has also developed improved cultural, agronomic practices which are transferred via CIP's training programme for better land preparation, planting, crop care, harvesting and food storage. The mix and intensity of application of new technologies in specialized areas of research depend on the country or region

for which the training activity is conducted. New technologies introduced to national programmes include: on-farm research, identification and control methods for major pests and diseases, proper field inspection procedures, laboratory systems for virus testing and low-cost diffused-light seed storage (to reduce sprouting). Methodologies to conduct on-farm research are important, as they facilitate interaction between national research and extension personnel and farmers to identify constraints as perceived by the farmers. In this manner, technical aspects are treated in relation to the real world conditions. Therefore, only those pests, diseases and other factors considered economically important are covered in depth. Three courses, involving 50 participants from four countries, were undertaken in on-farm research. They were started with discussions to elicit production constraints as perceived by the participants and followed by discussion on research methods or actual experience with farmers using the methods. National programme personnel have a special interest in rapidly multiplying tubers or plants which are known to be free of disease. Specialized training in tissue culture techniques and methods of preventing disease and pest transmission were initiated by CIP and the other two institutes. During 1980-1982, CIP held six short courses in collaboration with nine Latin American and Asian country programmes to introduce low-cost storage technologies which will reduce loss during winter storage months. The 252 participants included personnel from ministries of agriculture, the extension services as well as farmers. Fifty-one national researchers also participated as course instructors.

Sweet potatoes and cassava at IITA

18. During the past decade, IITA has made significant progress in producing improved varieties of cassava and sweet potatoes which are resistant to the major root crop diseases in Africa, cassava mosaic disease (CMD), cassava bacterial blight (CBB) and the sweet potato disease complex (SPVD). They are high-yielding, acceptable to consumers as well as adaptable to a wide range of environment. Advanced training was provided during 1980-1981 for two plant breeders from India and Sierra Leone to investigate ways to identify and select superior germ plasm. The seed from improved varieties has been distributed to national programmes, then successfully selected and evaluated under local conditions and subsequently multiplied for release in several African countries. IITA has attacked pest problems through genetic resistance research and breeding and by using biological control means that have been developed in collaboration with CIAT. IITA has also developed similar programmes for yams and cocoyams. Tissue culture courses, held in conjunction with CIP, provided 21 participants opportunities to learn the latest techniques for producing disease-free plants. To facilitate interaction between country collaborators, a germ plasm exchange workshop was held in 1982 to bring together cassava and potato programme leaders and agricultural quarantine officers. This highly successful workshop produced viable solutions to overcoming quarantine requirements which restrict intercountry germ plasm movement.

19. As the number of skilled African personnel working in national programmes is not as great as in Latin America and Asia, IITA has responded by focusing a large proportion of its training programmes on meeting the pressing needs of Africa. Forty-one Asian and African personnel participated in courses for multidisciplinary

research training applicable to all root and tuber crops. IITA held two African regional root crop workshops and five familiarization visits to IITA for national research and extension personnel.

20. As a result of the specialized training workshops held by the centres, a Cassava Production Manual is now available in French and English and a comprehensive compilation of in-depth cassava production techniques entitled "Yuca: Investigación, Producción y Utilización" has been published and distributed. Other proceedings of the various workshops have been made available.

Collaboration

21. As appendix 1 illustrates, extensive collaboration with national programmes was facilitated by the inclusion of national personnel in the project's courses and workshops, as well as many of the project's activities were held in-countries and sponsored by the centres and national institutes. National personnel were employed in several of the workshops as instructors.

III. OUTLOOK FOR THE FUTURE

22. Transfer of technology on root and tuber crops by international centres and national programmes of selected interested countries has been made possible by the assistance of this project. In the light of the objectives, emphasis has been placed on the strengthening of national research and extension programmes to enable them to conduct co-operative as well as independent research to solve their own national production constraints. The project has contributed substantially to that objective in national programmes for root and tuber crops in many countries of the developing world.

23. Cassava research has been progressively strengthened through CIAT's efforts in Mexico, Cuba, Brazil, the Dominican Republic and Colombia, and is starting to develop in Haiti, Panama, Peru, Bolivia and Paraguay as research teams are being trained. Improved cultural practices and new germ plasm from CIAT have been tested in these countries and delivered to farmer's field, or they are in the process of evaluation through the action of this project.

24. CIP's improved germ plasm was introduced to developing countries as (a) advanced clonal selections and varieties and (b) tuber families and true seed from CIP breeding programmes and from breeding programmes collaborating with CIP. There are 83 developing countries that produce potatoes in the regions of the world where CIP operates. Currently, 58 of these countries are evaluating CIP genetic material. Already, 29 of these have either selected, released or named clones. Since it takes from 10 to 15 years to develop a variety and longer for it to enter a seed production scheme, this project has not yet had a visible impact in making new varieties of potatoes available to developing countries. However the potential for improving the quality of existent varieties is great, given the number of persons trained and the areas of the world covered with this project. Nevertheless, although success stories occasionally filter in, the effectiveness of this project will not be known until an accurate follow-up evaluation is conducted.

25. The adoption of low-cost diffused-light storage is very positive. A recent CIP survey indicated that some 864 storage facilities have been constructed in various countries of the developing world, adopting this new technology. Part of this success can be attributed to this project.

26. The impact of IITA's root and tuber programme on the transfer of technology is reflected in the distribution of improved varieties of cassava, sweet potatoes and yams in several countries in Africa. IITA's cassava multiplication programme supplied approximately 6 million cuttings to the Nigerian private sector and helped four contract farmers to multiply cassava on their farms for distribution, in response to popular demand. Among those who have received improved materials from IITA are the Nigerian National Seed Service and the Root Crops Research Institute.

27. Since 1980, up to 10,000 hectares of improved cassava are being planted annually in Nigeria. The acreage under these improved materials is increasing at a phenomenal rate. These improved cassava populations have also been sent to national programmes in Angola, Benin, Cameroon, the Congo, Gabon, Ghana, India, Liberia, Rwanda, Seychelles, Sierra Leone, the United Republic of Tanzania, Togo and Zaire. From these improved populations, improved cassava varieties have been developed and released in Gabon, India, Liberia, Seychelles, Sierra Leone and the United Republic of Tanzania. The improved cassava varieties yield on the average from 15 to 30 tons per hectare as compared with 5 to 10 tons per hectare for local varieties.

28. Five improved sweet potato varieties resistant to weevils and sweet potato virus, the most serious pest and disease, respectively, of sweet potato in tropical Africa, with high levels of consumer acceptance, good storage characteristics and yields of 10 to 20 tons per hectare in four months without fertilizers, have been developed and distributed to many centres in tropical Africa and elsewhere. A tissue culture facility has been developed for multiplication of improved clonal materials of sweet potato and virus indexing, thereby facilitating the supply of IITA's disease-free sweet potato varieties to many African, Asian and South and Central American countries. In 1981, for the first time, IITA's tissue culture laboratory distributed disease-free sweet potato and cassava clonal material to 17 countries in Africa. From populations of improved high-yielding, virus-resistant and weevil-resistant IITA materials, improved sweet potato varieties have been developed locally and released in Cameroon, Gabon, Liberia, Seychelles, Sierra Leone and the West Indies.

29. While the impact of training is difficult to measure, there is no doubt that competencies of national research and extension programmes in the various fields covered by this project have been improved. In the future, allowing the competencies of trained persons to work in improving cultural practices and germ plasm available to farmers, will lead to an impact of this project on production that will be clear and measurable.

30. In June 1982, the UNDP Governing Council approved a second phase of the project covering the five-year period from 1982-1987 (DP/PROJECTS/REC.7). Specific objectives are essentially the same as the project's first phase, with expanded

project activities. UNDP has also made provision for an in-depth evaluation of the impact both projects will have on developing the capacities of national programmes, as well as examining the transfer of improved technologies (including germ plasm) to the farmers.

* * *

Appendix 1

A COMPILATION OF TRAINING ACTIVITIES OF TECHNOLOGY TRANSFER ON ROOT AND TUBER CROPS
CLO/79/013

I. JOINT CENTRE ACTIVITIES

Type	Participating centres	Participating national programmes	Number of participants
Tissue culture techniques courses	IITA/CIP	Pangladesh, Burundi, Cameroon, Central African Republic, Ethiopia, Gambia, Guinea, Indonesia, Kenya, Liberia, Nigeria, Rwanda, Sierra Leone, Senegal, Togo, United Republic of Tanzania, Zimbabwe	21
Tissue culture techniques courses	CIAT/CIP	Brazil, Colombia, Ecuador	5
Quarantine and research workshops	CIAT/CIP	Argentina, Brazil, Cameroon, Chile, Colombia, Congo, Cuba, Dominican Republic, Ecuador, Ghana, India, Indonesia, Kenya, Republic of Korea, Liberia, Malawi, Mexico, Nigeria, Philippines, Rwanda, Seychelles, Sierra Leone, Somalia, Thailand, Togo, United Republic of Tanzania, Viet Nam, Zimbabwe	51

II. CIAT ACTIVITIES

Type	Participating national programmes	Number of participants
Multidisciplinary training	Brazil, Colombia, Ecuador, Panama	14
Discipline-specific training	Brazil, Colombia, Costa Rica, Cuba, Ecuador, Mexico, Paraguay, Peru, Thailand	19
In-country production and utilization courses	Brazil, Colombia, Dominican Republic, Haiti, Mexico	140
Integrated pest control course	Brazil, Colombia	6
Tissue culture course	Brazil, Costa Rica, Cuba, Dominican Republic, Ecuador, Mexico, Nicaragua, Paraguay, Venezuela	11

III. CIP ACTIVITIES

Type	Participating national programmes	Number of participants
Low-cost storage course	Bangladesh, Bhutan, Colombia, Ecuador, India, Peru, Sri Lanka, Uruguay	252
Seed production course	Bangladesh, Bhutan, India, Pakistan Philippines, Sri Lanka, Thailand, Viet Nam	24
On-farm research (agronomy) courses	Bangladesh, Bolivia, Burma, Burundi, Colombia, Ecuador, Indonesia, Republic of Korea, Madagascar, Peru, Philippines, Rwanda, Venezuela, Zaire	50

IV. IITA ACTIVITIES

Type	Participating national programmes	Number of participants
Discipline-specific training	India, Sierra Leone	2
Root and tuber crop production courses	Brazil, Burundi, Cameroon, Central African Republic, Congo, Cuba, Gabon, Gambia, Ghana, Guinea, Ivory Coast, Kenya, Liberia, Malawi, Philippines, Rwanda, Senegal, Sierra Leone, Sri Lanka, Somalia, Togo, Trinidad, Uganda, United Republic of Tanzania, Zaire, Zambia, Zimbabwe	41
Regional root crops workshop	Held in Liberia and Rwanda and attended by participants from most African countries	143
Familiarization visit	Bangladesh, Cameroon, Ghana, Liberia	5
	Total	784

Appendix 2

Numbers of Professionals in National Programmes Trained under GLO/79/013 by Country

The boundaries shown on this map do not imply official endorsement or acceptance by the United Nations.